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1. Introduction

It is found that psychological instability is one of the most widely recognized illnesses like diabetes, heart diseases and so forth. Nowadays depression is also referred as Major Depressive Disorder (MDD) [1]. An individual might be experiencing depression if he or she give indications of extreme irritability, outrage, loss of enthusiasm for most loved activities, constant lament, thoughts of death or self destruction, aches or pain, migraine, issues of stomach related problems without any physical cause over a period of time. The reasons of depression can be personal or family record of depression, significant life changes, injury or stress, certain physical disease and drugs [18]. The essential point is early recognition of users showing indications of depression so that accurate diagnosis and treatment may start at the early stage. Depression if untreated may prompt unwanted effects apart from the disease itself; for example, increased chances of dangerous conduct like drug or liquor addiction make it hard to recover from different diseases and the disease itself may be prolonged for considerable length of time. The numbers are very upsetting as there are roughly 300 million individuals experiencing depression issue worldwide and this number is expected to grow each year [20]. Furthermore, it is found that the bigger portion of individuals experiencing depression is from low-income families [23]. Clearly there is a solid need to handle depression by identifying risks as quickly as possible. Recognizing depressed individuals can help us to find and help needy people who need special care.

Deep belief networks can be used for Image Recognition, Video Recognition and Motion Capture Data [37]. It uses probabilities & unsupervised learning. They are composed of binary latent variables and they contain both types of layers i.e. directed & undirected. Identifying depression from images is framed as a classification problem in the field of Deep Learning (DL). Identifying symptoms from image can give critical information about a user regarding his or her depression diagnosis. The current methodology using supervised machine learning to classify a tweet having depressive symptoms is based on exact string matching feature [15]. This method falls short on classifying different users' post having different intentions. This synopsis proposes a multimodel (combination of deep neural network models) for prediction of human depression using deep learning that will identify depression symptoms. We will analyze given image using different Deep Neural Networks after getting training from millions of images provided by the different image datasets[2][4][11][17][18].

2. Literature Review

In the field of image analysis and classification, numerous researchers have made appreciable efforts to create the several methods of image classification. Various efforts have been undertaken to address the analysis of image datasets.

Michel et al.(2014) predicted

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the value of a single self-reported severity of depression indicator for each recording in the

AVEC 2014 dataset (Audio-Visual Emotion recognition Challenge). They worked on the behaviour of people suffering from mood disorders.

M. Asgari et al. (2014) proposed that for problem of detecting depression, recordings of subjects' spoken utterances can be used. Audio sets and textual features from manual transcripts were used as datasets.

Andalibi et al. (2015) analyzed depressive images of Instagram social platform and their text. They performed complete analysis of depressive posts.

De Choudhury et al. (2016) developed a statistical method to identify depressed persons who can lead to suicidal attempts. They identified some markers in thoughts which are responsible for depression.

Jain et al.(2017) utilized artificial intelligent system for automatic depression scale forecasting.They used audio sets and textual features from manual transcriptsof AVEC2014 dataset.

Zhu et al. (2017) calculated beck depression inventory values from visuals. They worked on facial expressions and head motion. AVEC 2013 and AVEC 2014 databases were used.

Pampouchidou et al. (2017) proposed a method to assess categorical depression from variant of motion history image in which emphasize is given on Gabor-inhibited filtered data rather than actual image. They worked on AVEC 2014 dataset and cnn layer.

Pominova et al. (2018) used temporal MRI images generated during depression diagnostics and developed Voxelwise 3D Convolutional Neural Network Model.

T. Marwa et al.(2018)used a huge chunk of tweets as strings on Twitter dataset and found that Deep learning models namely CNN outperformed the other classification methods.

Kacem et al.(2018) detected depression based on Motion Dynamics of facial and head movement when a set of questions was asked based on experiments carried on depression.

Y. Chen et al.(2018)used data from WeChat friend circle and filtered positive and negative messages using textual data. It proposed that Deep learning network model can be used for perinatal depression screening to achieve similar results as the postnatal depression scale screening.

S. Song et al. (2018)performed clinical interviews of clinical patients in form of audios and videos of AVEC 2016 DAIC-WOZ database. In their study, gaze directions and head poses have been used as the human behaviour signals for the depression analysis

Sahar Harati et al.(2018) proposed to use an auxiliary emotion dataset to train a Deep Neural Network (DNN) model which was applied to audio recordings of MDD patients. It helped clinical management decisions during Deep Brain Stimulation (DBS) treatment of MDD patients.

Jazaery et al.(2018) present a method based on

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a novel framework to estimate the Beck Depression Inventory II (BDI-II) values from video data, which uses a 3D convolutional neural network to automatically learn the spatiotemporal features

of the face to predict the depression levels. Experiments were performed on theAVEC2013 and AVEC2014 depression datasets.

M.A. Haziq et al.(2018) surveyed depression

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by applying 3 deep learning methods of CNN. These methods are transfer learning using AlexNet, fine-tuning using AlexNet & building end to end CNN.

Krishna et al.(2018) studied the image classification by deep learning utilizing AlexNet architecture with CNN.4 test images were edited from the ImageNet database and trials were led.

He Lang et al.(2018) showed

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hand-crafted and deep-learned features which measure the intensity of depression from speech. They first built Deep Convolutional Neural Networks (DCNN) to learn deep-learned features from spectrograms and raw speech waveforms.

A.H. Orabi et al.(2018) attempted to recognize the most efficient neural network architecture in natural language processing tasks to identify individuals with indications of depression.

P. Kharel et al. (2019) investigated various applications of ML for early identification of depression. Also a review on treatment response prediction is also done.

Lam et al. (2019) proposed a Deep 1D CNN and Transformer models achieved state-of the art performance for audio and text modalities by working on clinical interviews of clinical patients in form of audio and video.

L. Rosa et al.(2019) presents a Knowledge-Based Recommendation System (KBRS), which includes an emotional health monitoring system to detect users with potential psychological disturbances, specifically, depression and stress.

Ragab et al.(2019) presented two DCNN architectures, a shallow DCNN and a pre-trained DCNN model to detect breast cancer from 8000 mammographic images of Mammography database. They have performed comparative study with a second deep learning algorithm Stacked Auto Encoders (SAE) in terms of accuracy.

Abdellatef et al.(2020) introduced an integrated biometric method to parallelly identify face, iris, palm print, fingerprint and ear biometrics. The proposed method is based on the integration of the extracted deep-learned features and hand-crafted features.

Above related work shows the study of various methods which have used different data sets for image analysis, image features extraction and classification. There are some research gaps in this area which are as following:

• Face detection from an image is still a challenging task.

•

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Although progress has been made in automatic depression assessment, but most of the recent works only focus on the paralinguistic information

such as text, audio and video; rather than the linguistic information like facial expressions. • At present sentiment analysis tasks are done on the basis of keyword and emoji matching. Although some researchers have performed task on the basis of head and eyes movement of users on web cam while using internet but for the still images of depressed patients, a lot need to be done. • More precise image analysis by more effective deep neural network architecture is required. The chosen architecture will be used to detect users having symptoms of depression.

3. Rationale

In recent years, numerous research has been performed which focused on studying psychological health issues. Some questionnaires methods are also used to identify symptoms of the person. These clinical methods may fail as they are dependent on the memory of the user and the questionnaire variations. Some recent research focuses on the text, audio and video only rather than facial expressions. But when we add both of these factors i.e. depression and image analysis of linguistic parameters; only a few researches came to our knowledge which identifies depressed individuals using deep learning techniques.

In this research, we focus on developing a deep neural network architecture which will first detect face in the given image and then identify symptoms of depression on that face. Deep belief networks are subset of deep neural networks algorithms that are based on human brain, having ability to recognize patterns and process complex information [37]. These opportunities inspire us to propose our research work on the image analysis for depression symptoms using Deep Neural Networks.

4. Objectives

The aim of work is to design a multimodel for the prediction of human depression, using deep learning. In order to achieve aim, the following objectives are identified:

• To study and analyze existing Deep learning based model for depression prediction & data classification.

• To propose a Multimodel for the Prediction of Human Depression level using Deep Neural Network by identifying image features.

• To design Multimodel for Prediction of Human Depression.

• To perform the evaluation of proposed model in the terms of prediction accuracy, time complexity with less memory utilization and less error rate.

5. Research Methodology

The methodology for the proposed work is as follows:

• Data Collection – In the data collection phase, datasets are derived from image datasets[2][4][11]. These image datasets contains collection of different images of millions of users who are struggling with depression. These images can be utilized for learning the identification of depressed person.

• Image Classification- After data collection, image classification will be done whether the image contains the individual's face or not.

• Feature Extraction- To extract features from image, existing deep learning neural networks are used.

• Designing Multimodel - To extract the features of depression from an image, a multimodel architecture is designed and gets it trained by millions of images of different users provided by trained datasets.

• Image Categorization – Supervised classifiers are created by learning the types of images from existing images in the datasets. The learned classifier will be used for classification of depressed users.

Image Dataset will be used to train proposed model [2][4][11][17][18][39]. Scala and Python will be used for larger data set processing. Spark tool can be used on Hadoop for the distributed storage and processing of big data sets. Hadoop operates by splitting files into large blocks of data and then distributing those datasets across the nodes in a cluster. It then transfers code into the nodes, for processing data in parallel. IBM Watson tool provides environment for big data processing. It helps data scientists and developers accelerate AI and machine-learning deployment. Huge amount of dataset can be upload on Google Drive on paid basis or Amazon Web Services (AWS) which provide on demand cloud computing platforms and APIs.

Prediction accuracy can be improved by focusing on both image analysis of facial expression and motion dynamics of eyes, lips , head and hands movement [7].

To compute time and space complexity, if we can exploit certain properties of the problems [19], such as having a metric distance measure, then we can reduce the running time using data structures K-D (K-dimensional) trees [41]. Another approach would be probabilistic algorithms and data structures such as LSH (locality-sensitive hashing) [42] and randomized SVD (singular value decomposition) to improve run time [43].

Deep learning algorithms generally process complex & large datasets containing a large number of features to get meaningful information. In most cases, these algorithms have high computational complexity issues while processing large datasets due to the presence of lesser weight features (irrelevant or redundant). As a result, the computing increases with increase in the no. of features, no. of records, features types and inbuilt features categories present in datasets. Appropriate feature selection before applying Machine Learning Algorithms will be used as a solution to resolve the computing speed and accuracy issues effectively during processing of large datasets.

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Table 5.1 Datasets for depression detection systems

Dataset	Modality	Depression Annotation
AVEC 2013 [17]	A + V V	BDI-II (300 videos) (3ideos)
AVEC 2014 [2][4][11][17][18]C 2014	A + V	BDI-II
AVEC 2017 [39]	A + V	BDI-II
Crisis Text Line	T	Manual

annotation for depression DAIC A + T + V PHQ-8(65,024 forum posts) Dementia Bank Database A + T + V HAMD

Input Image Dataset

Select the face part for pre-processing

Point out the part for extraction

Pre processing phase

Feature Extraction

Feature Selection

Applying proposed Multimodel

Deep Learning Multimodel

Trained Data Set

Feature Extraction

Getting the Final Results

Figure 5.1 Flow Diagram of Proposed Multimodel

Multimodel will have multiple convolutional layers, multiple Rectified Linear Units (ReLu), multiple (max pooling) layers, fully connected layers. It is combination of multiple deep neural networks. VGG Face is an extended CNN used for

acquisition of image. It is used for performance improvement of existing CNN. The proposed model deals with depression recognition from single image or a set of images tracked in a video. DBN stands for Deep Belief Networks. COSFIRE (Combination Of Shifted FIlter REsponses) is a trainable filter method which can be used for pattern recognition in numerous computer vision tasks.

6. Expected Outcomes:

1. Proposed model will be able to foresee mental health status of an individual from his/her image. 2. It will be able to analyze and predict people's psychological state. 3. It will be able to save so many precious lives which our society lost due to suicidal attempts taken due to peer pressure, broken dreams, losing jobs, breakups with partners, etc.

7. Applications:

1. It predicts mental health status of human being from his/her image by applying image analysis. 2. It predicts depression of an interviewer and interviewee from a video by segmenting it in multiple images. 3. It performs sentiment mining of users' images. 4. It assesses social tensions in our society. 5. In current scenario of COVID-19, doctors can use this model to identify depressive symptoms of patients by connecting online through mobile or computer to follow social distancing.

1

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the value of a single self-reported severity of depression indicator for each recording in the

the value of a single self-reported severity of depression indicator for each recording in the

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a novel framework to estimate the Beck Depression Inventory II (BDI-II) values from video data, which uses a 3D convolutional neural network to automatically learn the spatiotemporal features

a novel framework is to estimate the Beck Depression Inventory II (BDI-II) values from video data, which uses a 3D convolutional neural network to automatically learn the spatiotemporal features

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3/6	SUBMITTED TEXT	29 WORDS	73%	MATCHING TEXT	29 WORDS

by applying 3 deep learning methods of CNN. These methods are transfer learning using AlexNet, fine-tuning using AlexNet & building end to end CNN.

by applying three deep learning techniques of Convolutional Neural Network (CNN). These techniques are transfer learning using AlexNet, fine-tuning using AlexNet and building an end to end CNN.

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hand-crafted and deep-learned features which measure the intensity of depression from speech. They first built Deep Convolutional Neural Networks (DCNN) to learn deep-learned features from spectrograms and raw speech waveforms.

hand-crafted and deep-learned features which can effectively measure the severity of depression from speech. In the proposed method, Deep Convolutional Neural Networks (DCNN) are firstly built to learn deep-learned features from spectrograms and raw speech waveforms.

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Although progress has been made in automatic depression assessment, but most of the recent works only focus on the paralinguistic information

although great progress has been made in automatic depression assessment,   most of the recent works only concern audio and video paralinguistic information,

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Table 5.1 Datasets for depression detection systems

Dataset

Modality

Depression Annotation

AVEC 2013 [17]

A + V V

BDI-II (300 videos) (3ideos)

AVEC 2014 [2][4][11][17][18]C 2014
A + V
BDI-II

AVEC 2017 [39]
A + V
BDI-II

Crisis Text Line
T
Manual

Table 3.1: Datasets for depression detection systems
Dataset Modality Depression
Annotation
AVEC 2013 A + V BDI-II (Valstar et al., 2013)
AVEC 2014 A + V BDI-II
(Valstar et al., 2014)
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